REMARKS

By this amendment the specification and claims 1, 8, and 9 have been amended. Claims 1-16 remain pending. Reconsideration of the application as amended is respectfully requested.

A marked-up version of the specification and claims showing the changes made is submitted in Appendix I.

Rejections under 35 USC §112

Claims 1, 8, and 9 have been rejected under 35 USC §112 as not having support for the negative limitation "in the absence of a photoresist layer."

The limitation "in the absence of a photoresist layer" as described in claims 1 and 8-9 has basis in the original disclosure, and in fact is literally supported by the application as filed. For example, neither of FIGS. 1 and 2 depict a photoresist layer, and the first line of paragraph [0015] states that "[t]he structure of FIG. 1 is subjected to an inventive etch as described above." As it is the structure depicted in FIG. 1 which is described as being etched, and FIG. 1 depicts no photoresist layer, literal support is provided. It is submitted that the negative limitation of claim 8 is permitted, for example under MPEP §2173.05(i).

Further, it is well known in the art, and persons skilled in the art would readily appreciate, that an etch such as an anisotropic etch used to form spacers and to transform the structure of FIG. 1 into the structure of FIG. 2 would be performed in the absence of a mask, and thus requires no photoresist layer. Thus it is clear that the inventor, at the time of filing of the application, had in his possession the exemplary embodiment of using the inventive, highly-selective etch chemistry of the present embodiment to form spacers in the absence of a photoresist layer. Thus the recitation is proper under 35 USC §112.

The amendment to paragraph [0015] which describes etching in the absence of a photoresist layer merely states in text what is depicted by FIGS. 1 and 2 and adds no new matter.

Rejections under 35 USC §102

Claim 8 has been rejected under 35 USC §102(e) as being anticipated by Pradeep et al. (US 6,337,262).

Pradeep recites forming patterned photoresist layer 16, then etching silicon nitride layer 14 using CHF_3 alone (FIGS. 2-3 and column 5 line 55 through column 6 line 12). After etching the silicon nitride layer 14, the photoresist layer is removed (column 5 lines 63-67). After forming trenches 20 and removing photoresist 16, silicon dioxide layer 22 is formed and the silicon nitride 14 is removed using hot phosphoric acid (column 6 lines 35-40).

The present invention as recited in claim 8 comprises novel and nonobvious differences from the invention of Pradeep. For example, claim 8 recites "etching said silicon nitride in the absence of a photoresist layer with an etch consisting essentially of oxygen and one of CHF_3...". As Pradeep does not recite the use of O_2 during the etch of silicon nitride 14 using CHF_3, claim 8 is allowable under 35 USC §102(e) for this reason alone.

Further, Pradeep fails to recite or suggest etching the Si_3N_4 layer using CHF_3 and O_2 in the absence of a photoresist layer. Pradeep etches Si_3N_4 layer with CHF_3 alone at FIG. 2 to form the structure of FIG. 3 while photoresist layer 16 is in place. Pradeep removes silicon nitride layer 14 using hot phosphoric acid. Thus claim 8 is further allowable over the invention of Pradeep under 35 USC §102(e).

The Examiner states that Pradeep etches "the silicon nitride after the photoresist (16) is removed," however Pradeep clearly etches the silicon nitride with CHF_3 alone when the photoresist layer is in place (see FIGS. 2 and 3, and column 5 line 63-column 6 line 12). After patterning silicon nitride 14 and removing photoresist layer 16, Pradeep removes silicon nitride 14 using hot phosphoric acid (column 6 lines 25-40).

Pradeep also recites etching silicon nitride using CH_3F (i.e. not CHF_3 as instantly claimed), argon, and oxygen (column 6 lines 1-3). However, as claim 8 recites the use of CHF_3 (not CH_3F) and oxygen, while Pradeep recites CH_3F, oxygen, and argon, claim 8 is allowable under 35 USC §102(e) over Pradeep.

The Examiner further states that since argon is an inert gas it does not materially affect the "basis and novel characteristics of the chemical etching process" (emphasis included in the Examiner's rejection). Claim 8, however, does not limit the etch to the stated etchants plus any mechanical etchant. Argon is clearly a known etchant which can erode a layer to be etched, much in the manner of sandblasting. Thus by adding argon, a mechanical etchant, the etch would become less selective by eroding layers indiscriminately. The Examiner's assertion that argon is not an etchant is respectfully traversed, and the Applicants have provided evidence to support this in the previous response: US patent 5,580,821 discloses the use of argon as the sole etchant at column 3 lines 51-56.

As this mechanical etchant clearly materially affects the basic and novel characteristics of the claimed invention as evidenced by the cited reference, Applicant has met the burden of showing that the introduction of the additional component would materially change the characteristics of Applicant's invention in accordance with MPEP §2111.03. Claim 8, which recites the use of an etch "consisting essentially of oxygen and ... CHF_3..." is clearly novel, nonobvious, and allowable under 35 USC §102 over Pradeep's recitation of CH_3F, argon, and oxygen at column 6 line 3.

Finally, Pradeep does not teach or suggest the recitation in the claim as amended of "...wherein said etchant comprises at least about 75% oxygen and less than about 25% of said at least one of CHF_3 and CH_2F_2." Thus claim 8 is allowable under 35 USC §102(e) over Pradeep for this reason alone.

Rejections under 35 USC §103

Claims 1, 3, and 5 have been rejected under 35 USC §103(a) over Pradeep et al. in view of Bosch (US 5,262,716).

The Examiner states that Pradeep discloses a method for etching a silicon nitride layer after the resist mask is removed in previous step with oxygen and CH_3F, and refers to FIGS. 4-5 and column 6 lines 1-7.

It is respectfully submitted that the Examiner has mischaracterized Pradeep, and that Pradeep does not recite what the Examiner suggests. The text at column 6 lines 1-7 teaches that it is the structure of FIG. 2 which has resist 16 in place that can be etched with CH_3F, argon, and oxygen, or by using CHF_3 alone. At FIG. 4, the silicon nitride 14 is removed after forming silicon dioxide 22 using hot phosphoric acid (column 6 lines 35-40).

The combination of Pradeep and Bosch, therefore, fails to teach or suggest "etching said silicon nitride layer in the absence of a photoresist layer with an etchant consisting essentially of oxygen...and one of CHF_3 and CH_2F_2...". Pradeep teaches etching in the presence of a photoresist layer, and also teaches using CH_3F along with O_2 and argon, not using CHF_3 and oxygen as recited in claims 1, 3, and 5. Pradeep recites using CHF_3 alone to etch silicon nitride at column 6 line 10.

The Examiner states that Pradeep teaches argon in the etching composition with oxygen and CHF_3. This is clearly incorrect, as Pradeep teaches argon in the etching composition with oxygen and CH_3F, not CHF_3 (column 6 lines 2-3) and using CHF_3 alone (column 6 line 10).

In the rejection under 35 USC §103, the Examiner again states that since argon is inert it cannot affect the "basis and novel characteristics of the chemical etching process." However, as recited relative to the rejection under 35 USC §102, argon is clearly an etchant as evidenced by the cited reference which uses argon as the sole etchant (US patent 5,580,821, column 3 lines 51-56). Pradeep itself states an "SiN removal process with etchant gasses $CH_3F/Ar/O_2$" (column 6 lines 2-3) and is thus referring to argon as an etchant gas. The Examiner states that Pradeep uses argon as a diluent, but this is contrary to the teaching of Pradeep, which clearly refers to argon as an etchant gas. The Examiner's statement that argon is not an etchant is respectfully traversed.

Because argon as a mechanical etchant clearly materially affects the basic and novel characteristics of the claimed invention as evidenced by the reference cited by the Applicant in the previous response, Applicant has met the burden of showing that the introduction of the additional component would materially change the characteristics of Applicant's invention in accordance with MPEP §2111.03. Claim 1, which recites the use of an etch "consisting essentially of oxygen and ... CHF_3..." is clearly novel, nonobvious, and allowable under 35 USC §103 over Pradeep's recitation of CH_3F, argon, and oxygen at column 6 line 3 in combination with Bosch.

If the Examiner is submitting that argon is not a chemical etchant and acknowledges that argon is at least a mechanical etchant, again the reasoning is not understood as rejected claims 1 and 3-5 do not limit the etch to the listed chemical etchant plus any mechanical etchants, but instead recites "an etchant consisting essentially of oxygen...and one of CHF_3 and CH_2F_2" which would exclude the use of argon.

Pradeep and Bosch in combination further do not teach or suggest the added recitation of "...said etch comprises at least about 75% of said oxygen and less than about 25% of said one of CHF_3 and CH_2F_2." Thus Pradeep and Bosch in combination do not teach or suggest all of the features recited in rejected claims 1 and 3-5 as required, for example by MPEP §706.02(j), and are thus allowable over the combination of references.

Claims 1-16 have been rejected under 35 USC §103(a) as being unpatentable over Matsuo et al. (US 5,994,227) in view of Campbell et al. (US 5,994,227). Matsuo discloses a method comprising etching a silicon nitride layer after a resist mask is removed in a previous step with an etch consisting essentially of oxygen and CH_2F_2. Matsuo expressly teaches the inclusion of oxygen at a percentage less than 40% due to the release of excessive fluorine radicals which results in an isotropic etch, and greater than 25% (column 3 lines 42-52).

In clear contrast to the teachings of Matsuo and Campbell, claim 1 recites that the etch comprises "at least about 75% of said oxygen and less than about 25% of said one of CHF_3 and CH_2F_2." Thus, where Matson expressly teaches that the O_2 ratio must be below 40%, claim 1 recites that the O_2 component be significantly higher: at least 75%. Similar recitations are found in independent claims 8 and 9. (Support for this claim amendment is found at line 4 of paragraph [0010], which teaches an O_2:CHF_3 or O_2:CH_2F_2 flow rate ratio of greater than about 3:1, which has been converted to percentages. As expressly noted by the Examiner, such a conversion is within the ability of one having ordinary skill in the art.)

Thus Matsuo and Campbell in combination teach away from the present invention as recited in claims 1, 8, and 9. Applicant submits, therefore, that claims 1, 8, and 9, and the claims which depend therefrom, are therefore allowable under 35 USC §103 over Matsuo and Campbell in combination.

In the *Response to Arguments* the Examiner states that since the preamble recites "A method for etching a layer of silicon nitride *comprising*:," the claim is open for the inclusion of unspecified ingredients even in major amounts during the etch specified. It is respectfully submitted that while the term "comprising" in the preamble leaves the claim open to steps not specified, the phrase "an etchant consisting essentially of..." limits the etchant to only those materials specified and those that do not materially affect the basic and novel characteristics of the claimed invention. The instant specification throughout discusses etching silicon nitride selective to silicon and silicon dioxide. As argon is a mechanical etchant, adding this to the etchant would decrease the selectivity of the etch and increase the etch rate of silicon and silicon dioxide relative to the etch rate of silicon nitride, which for stated purposes of the invention is to be avoided. Because argon, as a mechanical etchant, would clearly materially affect the basic and novel characteristics of the claimed invention as evidenced by the cited reference

(US Pat. 5,580,821), Applicant has met the burden of showing that the introduction of the additional component would materially change the characteristics of Applicant's invention in accordance with MPEP §2111.03. Thus the present invention as claimed is novel and nonobvious over references which include argon as an etchant.

The rejected claims not individually addressed are allowable at least because they depend from an allowable base claim.

Conclusion

If the Examiner believes a conference would expedite prosecution of the case, the Examiner is cordially invited to call the undersigned. This is believed to be a complete and proper response to the Examiner's outstanding office action.

Respectfully Submitted,

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APPENDIX I
VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification

Paragraph [0015] has been amended as indicated below.

[0015] The structure of FIG. 1 is subjected to an inventive etch as described above. An exemplary etch includes processing the wafer in a chamber of an AME5000 etch chamber. After placing the wafer substrate assembly in the etch chamber, O_2 and CHF_3 or CH_2F_2 are introduced into the chamber at flow rates of about 60 sccm and about 20 sccm respectively. Pressure is maintained at between about 30 millitorr and about 40 millitorr, and a power of between about 300 watts and about 400 watts is utilized. At a chuck temperature of about 10°C and a sidewall temperature of about 20°C, the silicon nitride will etch at a rate of about 720Å/min in the vertical direction, and about 180Å/min in the horizontal direction. Generally, the vertical:horizontal etch rate will be about 4:1. For the 525Å thick layer of silicon nitride depicted in FIG. 1, the etch is performed <u>in the absence of a photoresist layer</u> for between about 35 seconds and about 60 seconds which results in the structure of FIG. 2. Spacers 32 having a width of about 300Å to about 400Å are formed. --

In the Claims

Claims 1, 8, and 9 have been amended as indicated below.

1. (twice amended) A method for etching a layer of silicon nitride comprising:

etching said silicon nitride layer in the absence of a photoresist layer with an etchant consisting essentially of oxygen at a flow rate of between about 20 sccm and about 80 sccm and one of CHF_3 and CH_2F_2 at a flow rate of between about 5 sccm and about 25 sccm, <u>wherein said etchant comprises at least about 75% of said oxygen and less than about 25% of said one of CHF_3 and CH_2F_2</u>; and

during said etching, subjecting said silicon nitride layer to a pressure of between about 10 millitorr and about 60 millitorr.

8. (twice amended) A method used during the formation of a semiconductor device comprising:

providing a semiconductor wafer assembly comprising at least one of a layer of silicon and a layer of silicon dioxide;

forming a layer of silicon nitride over said at least one of said layer of silicon and said layer of silicon dioxide;

etching said silicon nitride in the absence of a photoresist layer with an etch consisting essentially of oxygen and one of CHF_3 and CH_2F_2 and a pressure of between about 10 millitorr and about 60 millitorr, wherein said etch comprises at least about 75% of said oxygen and less than about 25% of said one of CHF_3 and CH_2F_2 and said etch exposes said at least one of said layer of silicon and said layer of silicon dioxide.

9. (twice amended) A method used during the formation of a semiconductor device comprising:

providing a semiconductor wafer assembly comprising a silicon wafer and a layer of silicon dioxide overlying said wafer;

forming a layer of silicon nitride over said silicon wafer and over said layer of silicon dioxide;

placing said semiconductor wafer assembly into an etch chamber;

etching said silicon nitride layer in the absence of a photoresist layer using an etch consisting essentially of oxygen and one of CHF_3 and CH_2F_2 and a pressure of between about 10 millitorr and about 60 millitorr to expose said silicon dioxide layer and said silicon wafer, wherein said etch comprises at least about 75% of said oxygen and less than about 25% of said one of CHF_3 and CH_2F_2.